

WHAT IS CLAIMED IS:

1 1. A drilling system for drilling a wellbore, comprising
2 (a) a drill string having a drill bit at an end thereof;
3 (b) a source of drilling fluid supplying drilling fluid under pressure into
4 the drill string (a "supply fluid"), the drilling fluid returning uphole via an annulus
5 around the drill string (a "return fluid");
6 (c) an active pressure differential device ("APD Device") associated
7 with the return fluid to create a pressure drop across said APD Device to reduce
8 pressure in the wellbore downhole of said APD Device;
9 (d) a drive assembly coupled to said APD Device for energizing said
10 APD Device; and
11 (e) a sealing member positioned between said APD Device and said
12 drive assembly, said sealing member at least partially providing a barrier
13 between the supply fluid and the return fluid.

1 2. The drilling system of claim 1 wherein said APD Device is selected from
2 one of (a) a positive displacement pump, (b) a centrifugal type pump, and (c) a
3 Moineau-type pump.

1 3. The drilling system of claim 1 wherein said drive assembly is selected
2 from one of (a) a positive displacement drive, (b) a turbine drive, (c) a electric
3 motor, (d) a hydraulic motor, (e) a Moineau-type motor, and (f) rotation of said
4 drill string.

1 4. The drilling system of claim 1 further comprising a bypass for selectively
2 diverting fluid around one of said APD device and said drive assembly.

1 5. The drilling system of claim 1 further comprising a speed converter
2 interposed between drive assembly and said APD device, said speed converter

3 being adapted to convert a first speed associated with said drive assembly to a
4 selected second speed associated with said APD device.

1 6. The drilling system of claim 5 wherein said speed converter is selected
2 from a group consisting of (i) a gear drive, (ii) a hydrostatic drive, and (iii) a
3 hydrodynamic drive.

1 7. The drilling system of claim 1 further comprising a comminution device
2 positioned downhole of said APD device, said comminution device configured to
3 reduce the size of cuttings entrained in the return fluid.

1 8. The drilling system of claim 7 wherein said comminution device includes a
2 shaft coupled to a rotor associated with said APD Device and a conical head
3 mounted on an end thereof, said shaft having a radial motion corresponding to
4 an eccentric motion of said rotor, said conical head thereby engaging and
5 reducing the size of the cuttings.

1 9. The drilling system of claim 1 wherein said APD Device comprises a
2 centrifugal type pump and said comminution device comprises a shearing
3 member configured as a stage in said centrifugal type pump.

1 10. The drilling system of claim 1 further comprising an annular seal disposed
2 around said APD device, said annular seal causing the return fluid to flow into
3 said APD device and allowing said APD device to create a differential pressure
4 thereacross.

1 11. The drilling system of claim 1 further comprising a controller that controls
2 the operation of said APD Device.

1 12. The drilling system of claim 11 wherein said controller is located at one of:
2 (i) at the surface; (ii) in a drilling assembly attached to the drill string; and (iii)
3 adjacent said APD Device.

1 13. The drilling system of claim 11 wherein said controller controls said APD
2 Device in response to one of: (i) a parameter of interest; (ii) programmed
3 instructions provided to said controller; (iii) instructions from a remote location;
4 and (iv) a downhole measured parameter.

1 14. The drilling system of claim 11 wherein said controller includes one of (a)
2 microprocessor and a memory, and (b) a hydro-mechanical device.

1 15. The drilling system of claim 11 wherein said controller is positioned in the
2 wellbore; and further comprises a telemetry system for transmitting signals to
3 said controller.

1 16. The drilling system of claim 11 wherein said controller controls the
2 operation of said APD Device to control the pressure in the wellbore to one of: (i)
3 maintain the wellbore bottomhole pressure at a predetermined value; (ii) maintain
4 the wellbore bottomhole pressure within a selected range; (iii) maintain at-
5 balance condition; and (iv) maintain under-balance condition.

1 17. The drilling system of claim 1 further comprising a sensor for detecting a
2 parameter of interest.

1 18. The drilling system of claim 17 wherein said sensor detects a parameter
2 selected from a group consisting of (i) drilling parameters, (ii) drilling assembly
3 parameters, and (iii) formation evaluation parameters.

1 19. The drilling system of claim 17 wherein said sensor is positioned at a
2 predetermined location selected from a group consisting of (i) a surface location,

3 (ii) at said APD Device, (iii) at wellhead equipment, (iv) in the supply fluid, (v)
4 along said drill string, (vi) at a drilling assembly connected to said drill string, (vii)
5 in the return fluid upstream of said APD device, and (viii) in the return fluid
6 downstream of said APD device.

1 20. The drilling system of claim 1 further comprising a blocking device
2 downhole of said APD Device that blocks the return fluid flow when the drilling
3 fluid supply is interrupted or stopped.

1 21. The drilling system of claim 1 wherein said APD device is attached to one
2 of (a) said drill string, (b) a location stationary relative to said drill string, (c) the
3 annulus, and (d) a riser.

1 22. A drilling system for drilling a wellbore, comprising
2 (a) a drill string having a drill bit at an end thereof;
3 (b) a source of drilling fluid supplying drilling fluid under pressure into
4 the drill string (a "supply fluid"), said drilling fluid returning uphole via an annulus
5 around the drill string (a "return fluid");
6 (c) an active pressure differential device ("APD Device") placed in the
7 annulus to create a pressure drop across said APD Device to reduce pressure in
8 the wellbore downhole of said APD Device, said APD Device in fluid
9 communication with the return fluid; and
10 (d) an electric drive assembly being substantially isolated from the
11 supply fluid.

1 23. The drilling system of claim 22 wherein said electric drive assembly is
2 disposed in a location selected from (a) in housing that substantially isolates said
3 electric drive assembly from the supply fluid, and (b) on the outside of said drill
4 string.

1 24. The drilling system of claim 22 further comprising a speed converter
2 interposed between said drive assembly and said APD device, said speed
3 converter adapted to convert a first speed associated with said drive assembly to
4 a selected second speed associated with said APD device.

1 25. The drilling system of claim 24 wherein said speed converter is selected
2 from a group consisting of (i) a gear drive, (ii) a hydrodynamic drive, and (iii) a
3 hydrodynamic drive.

1 26. The drilling system of claim 22 further comprising a comminution device
2 positioned downhole of said APD device, said comminution device configured to
3 reduce the size of particles entrained in said drilling fluid.

1 27. The drilling system of claim 26 wherein said comminution device is
2 coupled to said drive assembly and energized thereby.

1 28. The drilling system of claim 26 wherein said comminution device
2 comprises a shearing member configured as a stage in a centrifugal type pump
3 associated with said APD Device.

1 29. The drilling system of claim 22 further comprising an annular seal
2 disposed around said APD device, said annular seal causing drilling fluid to flow
3 into said APD device.

1 30. The drilling system of claim 22 wherein said APD Device includes one of:
2 (i) a turbine; and (ii) a centrifugal pump.

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4 31. A method for drilling a wellbore, comprising

5 (a) providing a drill string having a drill bit at an end thereof;

6 (b) supplying drilling fluid under pressure into the drill string (a "supply
7 fluid"), the drilling fluid returning uphole via an annulus around the drill string (a
8 "return fluid");

9 (c) positioning an active pressure differential device ("APD Device") in
10 fluid communication with the return fluid to create a pressure drop across the
11 APD Device to reduce pressure in the wellbore downhole of the APD Device;

12 (d) coupling a drive assembly to the APD Device for energizing said
13 APD Device; and

14 (e) providing an at least partial barrier between the supply fluid and the
15 return fluid by positioning a sealing member positioned between the APD Device
16 and the drive assembly.

1 32. The method of claim 31 wherein said APD Device is selected from one of
2 (a) a positive displacement pump, (b) a centrifugal type pump, and (c) a
3 Moineau-type pump.

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5 33. The method of claim 31 wherein said drive assembly is operated by one
6 of (a) a positive displacement drive, (b) a turbine drive, (c) a electric motor, (d) a
7 hydraulic motor, (e) a Moineau-type pump, and (f) rotation of the drill string.

1 34. The method of claim 31 further comprising positioning a comminution
2 device downhole of the APD device, the comminution device configured to
3 reduce the size of cuttings entrained in the return fluid.

1 35. The method of claim 34 wherein the comminution device includes a shaft
2 coupled to a rotor associated with the APD Device and a conical head mounted
3 on an end thereof, the shaft having a radial motion corresponding to an eccentric
4 motion of the rotor, the conical head thereby engaging and reducing the size of
5 the cuttings.

1 36. The method of claim 34 wherein the APD Device comprises a centrifugal
2 type pump and the comminution device comprises a shearing member
3 configured as a stage in the centrifugal type pump.

1 37. The method of claim 31 further comprising disposing an annular seal
2 around the APD device, the annular seal causing the return fluid to flow into the
3 APD device and allowing the APD device to create a differential pressure.

1 38. The method of claim 31 further comprising controlling the operation of the
2 APD Device with a controller.

1 39. The method of claim 38 further comprising positioning the controller at one
2 of: (i) at the surface; (ii) in a drilling assembly attached to the drill string; and (iii)
3 adjacent the APD Device.

1 40. The method of claim 38 wherein the controller controls the APD Device in
2 response to of: (i) a parameter of interest; (ii) programmed instructions provided
3 to the APD Device; (iii) instructions provided to the APD Device from a remote
4 location; and (iv) a downhole detected parameter.

1 41. The method of claim 38 further comprising positioning the controller in the
2 wellbore; and transmitting signals to the controller via a telemetry system.

1 42. The method of claim 38 wherein the controller controls the operation of the
2 APD Device to control the pressure in the wellbore to one of: (i) maintain the
3 wellbore bottomhole pressure at a predetermined value; (ii) maintain the wellbore
4 bottomhole pressure within a selected range; (iii) maintain at-balance condition;
5 and (iv) maintain under-balance condition.

1 43. The method of claim 31 further comprising detecting a parameter of
2 interest with a sensor.

1 44. The method of claim 43 wherein the sensor detects a parameter selected
2 from a group consisting of (i) drilling parameters, (ii) drilling assembly
3 parameters, and (iii) formation evaluation parameters.

1 45. The method of claim 43 further comprising positioning the sensor at a
2 predetermined location selected from a group consisting of (i) a surface location,
3 (ii) at the APD Device, (iii) at wellhead equipment, (iv) in the supply fluid, (v)
4 along the drill string, (vi) at a drilling assembly connected to the drill string, (vii) in
5 the return fluid upstream of the APD device, and (viii) in the return fluid
6 downstream of the APD device.

1 46. The method of claim 31 further comprising attaching the APD device to
2 one of (a) the drill string, (b) a location stationary relative to the drill string, (c) the
3 annulus, and (d) a riser.

1 47. A method for drilling a wellbore, comprising
2 (a) providing a drill string having a drill bit at an end thereof;
3 (b) supplying drilling fluid under pressure into the drill string (a "supply
4 fluid"), the drilling fluid returning uphole via an annulus around the drill string (a
5 "return fluid");
6 (c) placing an active pressure differential device ("APD Device") in the
7 annulus to create a pressure drop across the APD Device to reduce pressure in
8 the wellbore downhole of the APD Device, the APD Device in fluid
9 communication with the return fluid; and
10 (d) driving the APD device with an electric drive assembly that is
11 substantially isolated from the supply fluid.

1 48. The method of claim 47 further comprising disposing the electric drive
2 assembly in a location selected from (a) in housing that substantially isolates the
3 electric drive assembly from the supply fluid, and (b) on the outside of the drill
4 string.

1 49. The method of claim 47 further comprising positioning a comminution
2 device downhole of the APD device, the comminution device configured to
3 reduce the size of particles entrained in the return fluid.

1 50. The method of claim 47 further comprising disposing an annular seal
2 around the APD device, the annular seal causing drilling fluid to flow into the
3 APD device and providing a pressure differential across the APD device.

1 51. The method of claim 47 wherein said APD Device includes one of: (i) a
2 turbine; and (ii) a centrifugal pump.